Department of Transportation
Federal Aviation Administration
Aircraft Certification Service
Washington, D.C.

TSO-C213

Effective
Date: 3/9/18

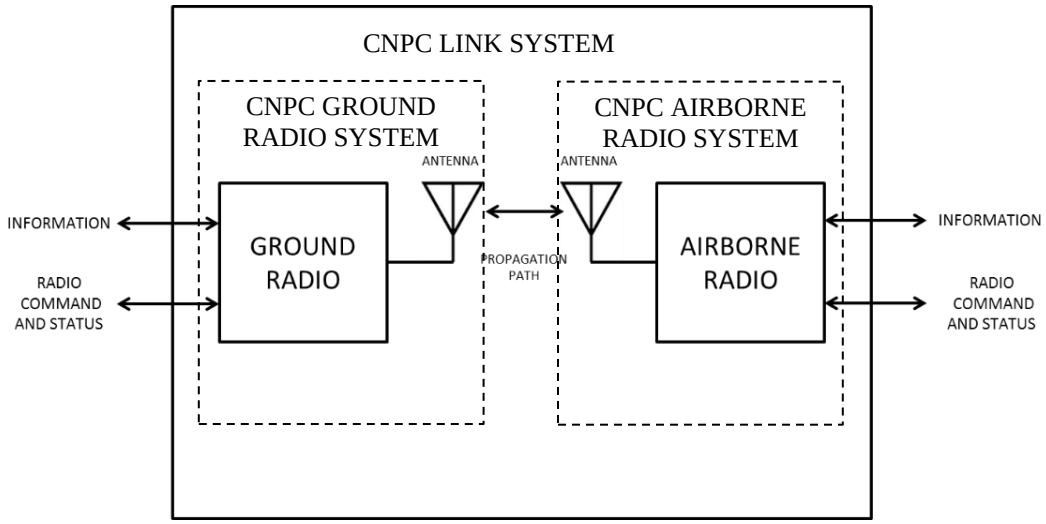
Technical Standard Order

Subject: Unmanned Aircraft Systems Control and Non-Payload Communications Terrestrial Link System Radios

1. PURPOSE. This technical standard order (TSO) is for manufacturers applying for a TSO authorization (TSOA) or letter of design approval (LODA). In it, we (the Federal Aviation Administration, (FAA)) tell you what minimum performance standards your Unmanned Aircraft Systems (UAS) terrestrial non-networked Control and Non-Payload Communications (CNPC) Link System radios operating in C Band, 5040-5050 megahertz (MHz), must meet for approval and identification with the applicable TSO marking.

The CNPC Link System, shown in figure 1, is comprised of a CNPC Airborne Radio System (ARS) and Ground Radio System (GRS) comprising radios and their corresponding antennas. This TSO is specifically for the airborne and ground radio components of the ARS and GRS.

Figure 1. CNPC Link System Components



2. APPLICABILITY. This TSO affects new applications submitted after its effective date.

3. REQUIREMENTS. New models of UAS CNPC Link System radios identified and manufactured on or after the effective date of this TSO must meet the requirements in Section 2 of RTCA Document RTCA/DO-362 with Errata, *Command and Control (C2) Data Link Minimum Operational Performance Standards (MOPS) (Terrestrial)*, dated September 22, 2016, with the corrections listed in Appendix 1 of this TSO. RTCA/DO-362 describes the features and characteristics needed by the CNPC Link System airborne and ground radios to achieve a terrestrial point-to-point communication functionality and radio line-of-sight operation to support UAS operating in the National Airspace System (NAS).

Note: It is necessary to examine the correct version of RTCA/DO-362, since versions with and without errata were published. There are no unique publication dates, or version with errata uniquely marked, or errata listed in the table of contents. The correct version contains the errata at the end of the document, after Appendix S.

Table 1 – UAS CNPC Link System Radio Classes

Referenced Radio	Frequency Band	Co-located (X) or Non-Co-located (Y) with C Band Avionics	ARS (A) and/or GRS (G) Antenna Transmit and Receive
Class 1 — Validation Baseline Radio	C Band (C)	X	Single (S) / Multiple (M) antenna(s)
		Y	Single (S) / Multiple (M) antenna(s)

CNPC Link System radio classes are defined by the avionics system with C Band ARS and GRS radios with antennas and co-located / non-co-located with other avionics systems defined in Table 1. These CNPC Link System radio classes must meet the following requirements in RTCA/DO-362: §§ 2.1.10, 2.1.12, 2.1.15, 2.1.16, 2.2.1.1, 2.2.1.1.1.b—2.2.1.1.3, 2.2.1.3—2.2.1.8.2.2, 2.2.1.8.3, 2.2.1.9, and 2.2.2. Classes 1CX and 1CY must meet the compatibility requirements for CNPC Link System ARS and GRS with co-located and non-co-located AeroMACS and Microwave Landing System (MLS), respectively, as described in RTCA/DO-362 §§ 2.2.1.8.2.2 and 2.2.1.8.3.

Note 1: The transmitting and receiving antenna(s) could be single or multiple depending upon UAS installation. In Table 1, A and G refer to ARS and GRS, S and M refer to single and multiple antenna(s), respectively.

Note 2: Since RTCA/DO-362 does not address interoperability between ARS and GRS radios, ARS and GRS radios designed and produced under this TSO must be designed and produced as a specifically interoperable ARS/GRS pairing, and are not considered interoperable with other ARS or GRS radios not designed to the same ARS/GRS

interoperability standard. Therefore, this TSO may not be used to design and produce incomplete TSO systems that provide CNPC ARS or GRS function only.

a. Functionality.

(1) This TSO's standards apply to CNPC Link System radios intended to provide information exchanges between the Pilot Station and the Unmanned Aircraft (UA) to allow the pilot to safely control, monitor, and manage the UA. This primary intended function includes capabilities and services associated with the CNPC Link System radio physical layers and some services associated with the CNPC Link System radio data link layers.

(2) The CNPC Link System radios also provide information exchanges between the Pilot Station and the UA to support one or more of the following functions as required by the expected operations of UAS in which they are intended to be installed and as defined in RTCA/DO-362, paragraphs 1.4.2 through 1.4.7: ATC voice and data relay, Detect-and-Avoid (DAA), weather radar, video, CNPC Link System management, frequency assignment, and CNPC Link System monitoring and alerting.

b. Failure Condition Classifications.

(1) Failure of the function defined in paragraph **3.a(1)** with a Pilot-In-The-Loop (PITL) or Pilot-On-The-Loop (POTL) control resulting in an undetected misleading information exchange by the CNPC Link System is a *hazardous/severe major* failure condition.

Note 1: Hazardous/severe major failure conditions for rotorcraft are defined in FAA AC 27-1B, *Certification of Normal Category Rotorcraft*, and AC 29-2C, *Certification of Transport Category Rotorcraft*.

Note 2: Hazardous and severe major failure conditions for airplanes are defined in AC 23.1309-1E, *System Safety Analysis and Assessment for Part 23 Airplanes*, and AC 25.1309-1A, *System Design and Analysis* (for transport category airplanes), respectively.

Note 3: In a PITL control, the pilot manually controls the UA with stick-and-rudder operation similar to a manned aircraft control. Some UAS use this PITL control to take-off and land the UA.

Note 4: There are two POTL control categories. In a basic POTL control, the pilot provides flight plan, manual setting of control targets and operation monitoring, and assumes control to the extent required if the UA deviates from the planned flight path or autopilot control targets. In the other POTL control capability to fly a programmed flight path, the pilot monitors the operation and assumes control to the extent required if the UA deviates from its programmed flight path.

(2) Loss of the function defined in paragraph **3.a(1)** with a PITL or POTL control is a *major* failure condition.

Note: This failure condition classification is based on a means provided to immediately either safely land the UA autonomously or otherwise terminate the flight with a managed energy state at ground contact (that minimizes hazards to persons and property on the surface) if the CNPC Link is lost and cannot be re-established in a time frame that permits safe continuation of the flight.

(3) Failure of the function defined in paragraph **3.a(2)** of the CNPC Link System supporting the DAA functionality resulting in misleading DAA alerting and/or guidance is as follows (refer to TSO-C211, *Detect and Avoid (DAA) Systems*):

(a) *Hazardous/severe major* failure condition for equipment supporting Class 2 DAA systems (incorporating Traffic Alert and Collision Avoidance System II [TCAS II] (Version 7.1) functions), for CNPC Link System failures that cause incorrect or missing TCAS II resolution advisories.

(b) *Major* failure condition for all other CNPC Link System failures resulting in misleading DAA alerting and/or guidance.

(4) Loss of the function defined in paragraph **3.a(2)** of the CNPC Link System supporting the DAA functionality is a *major* failure condition.

(5) Except for failure conditions of the CNPC Link System supporting the DAA functionality (paragraphs **3.b(3)** and **3.b(4)**), the failure conditions in paragraphs **3.b** may be assessed in conjunction with the UAS Risk Class for which the CNPC Link System equipment is intended to be used, as defined in Table 2. Table 2 gives UAS risk classes and required design assurance levels based on UA kinetic energy at ground impact. Compute the UA kinetic energy using the formula $\mathbf{KE = \frac{1}{2}mv^2}$, where **KE** is the UA kinetic energy in foot-pounds (ft-lbs), **m** is the maximum UA gross weight in pounds divided by 32.17, and **v** is the impact speed of the UA in knots (as defined in paragraphs **3.b(5)(a)** and **3.b(5)(b)** below for fixed-wing and rotorcraft/powered-lift UAS, respectively) multiplied by 1.688.

(a) Classification Scheme for Fixed Wing UAS. The FAA risk classification scheme for fixed wing UAS utilizes the kinetic energy of the UAS at design cruise speed. Cruise speed was chosen as a more favorable risk threshold than dive speed, since the falling mass speeds of a UAS subject to a catastrophic failure will theoretically be the same, ignoring drag and other design specific effects. You must define an expected cruise speed at which the UAS safely routinely operates.

(b) Classification Scheme for Rotorcraft and Powered Lift UAS. Since Vertical Take-Off and Landing (VTOL) aircraft have the capability to hover and routinely operate with very slow forward airspeeds, the method of using cruise speed would not be appropriate for determining impact energy. Therefore, energy calculations for these types of aircraft should utilize terminal velocity of the aircraft following a catastrophic failure of the UAS.

Note: Terminal velocity of a vertically falling object is the speed where aerodynamic drag on the falling object equals the object's weight. It is given by

the formula $\mathbf{V_t = (\sqrt{\ [2W/(\rho * C_D * S)]) / 1.688}}$, where $\mathbf{V_t}$ is terminal velocity in knots, **W** is the object's weight in lbs, **ρ** is air density in slugs/ft^3, $\mathbf{C_D}$ is the object's aerodynamic drag coefficient, and **S** is the object's cross-sectional area ("flat-plate" area perpendicular to direction of fall) in ft^2. Terminal velocity may also be determined experimentally and/or validated by testing. (Additional note: In English units of mass, one slug weighs 32.17 lb.)

Table 2 –UAS Risk Classes and Design Assurance Levels Based on Kinetic Energy

Risk Class	Kinetic Energy in Ft-Lbs	Design Assurance Levels (DAL) and Probability of Catastrophic Failure
1	≤ 529	DAL E, 10^{-4}
2	≥530 to ≤24,999	DAL D, 10^{-5}
3	≥25,000 to ≤799,999	DAL C, 10^{-6}
4	≥800,000 to ≤5,999,999	DAL C, 10^{-7}
5	≥6,000,000 to ≤49,999,999	DAL B, 10^{-8}
6	≥50,000,000	DAL A, 10^{-9}

Note: The DALs are applicable to the CNPC airborne and ground system radios. For the CNPC Link System, the DAL requirements of Table 2 are assigned corresponding to DAL B and hazardous/severe major failure condition for Risk Class 6.

(6) Design the system to at least the following design assurance levels:

(a) For CNPC Link System functionality supporting DAA (reference paragraph **3.a(2)**), develop the system to at least the design assurance level equal to the failure condition classification specified in paragraphs **3.b(3)** and **3.b(4)**.

(b) For all other CNPC Link System functionality, develop the system to at least the following design assurance level:

(1) The failure condition classification specified by paragraph **3.b(1)**, or,

(2) If you limit the CNPC Link System equipment to be used with UAS Risk Class 4 or below as defined in paragraph **3.b.(5),** Table 2, the DAL specified for the highest UAS risk class in paragraph **3.b.(5)**, Table 2, with which you intend the CNPC Link System equipment to be used. If you design the equipment to this DAL, include an installation limitation specifying the highest corresponding UAS risk class with which the equipment may be used, based on the highest UAS risk class the DAL supports according to Table 2, in accordance with paragraph **5.a.(5)(b)** of this TSO.

c. Functional Qualification. Demonstrate the required functional performance under the test conditions specified in RTCA/DO-362, corresponding section 2.4 appropriate for the CNPC Link System radio class.

d. Environmental Qualification. Demonstrate the required performance under the test conditions specified in RTCA/DO-362, corresponding section 2.3 using standard environmental conditions and test procedures appropriate for the system radio class. You may use a different standard environmental condition and test procedure than RTCA/DO-362, section 2.3, provided the standard is appropriate for the CNPC Link System radios.

> **Note:** The use of RTCA/DO-160D (with Changes 1 and 2 only, and without Change 3 incorporated) or earlier versions is generally not considered appropriate and will require substantiation via the deviation process as discussed in paragraph **3.h** of this TSO.

e. Software Qualification. If the airborne/ground system radios include software, develop the GRS and ARS software in accordance with RTCA, Inc. document RTCA/DO-178C, *Software Considerations in Airborne Systems and Equipment Certification,* dated December 13, 2011, including referenced supplements as applicable, to at least the software level consistent with the failure condition classification(s) defined in paragraph **3.b** of this TSO. You may also develop the software according to RTCA, Inc. document RTCA/DO-178B, dated December 1, 1992, if you follow the guidance in AC 20-115 (current version), *Airborne Software Development Assurance using EUROCAE ED 12() and RTCA DO-178()*. If the CNPC Link System GRS includes software, you may also develop the GRS software according to RTCA, Inc. document RTCA/DO-278A, *Software Integrity Assurance Considerations for Communication, Navigation, Surveillance and Air Traffic Management (CNS/ATM) Systems,* dated December 13, 2011.

f. Electronic Hardware Qualification. If the airborne and ground system radios include complex custom airborne/ground electronic hardware, develop the component in accordance with RTCA/DO-254, *Design Assurance Guidance for Airborne Electronic Hardware,* dated April 19, 2000, to at least the design assurance level consistent with the failure condition classification defined in paragraph **3.b** of this TSO. For custom airborne/ground electronic hardware determined to be simple, RTCA/DO-254, paragraph 1.6 applies.

> **Note:** Use RTCA/DO-254 for electronic hardware qualification of the airborne and ground system radios.

g. Security Requirements. Demonstrate that the required security protection specified in RTCA/DO-362, paragraph 2.1.10 is met.

h. Deviations.

(1) We have provisions for using alternate or equivalent means of compliance to the criteria in the MOPS of this TSO. If you invoke these provisions, you must show that your system maintains an equivalent level of safety. Apply for a deviation under the provision of 14 CFR § 21.618.

> **Note:** If you request deviations from the minimum operational performance requirements of RTCA/DO-362 § 2.2.2 / paragraph **3** of this TSO, MOPS Baseline

CNPC Link System Requirements, and the associated functional qualification requirements in RTCA/DO-362 § 2.4 / paragraph **3.c** of this TSO and use RTCA/DO-362 § 2.2.3, Manufacturer-Specific CNPC Link System Requirements, and the associated functional qualification requirements of RTCA/DO-362 § 2.4, you may consider showing equivalent level of safety by demonstrating compliance to RTCA/DO-362 §§ 2.2.3 – 2.2.3.7 and the associated functional qualification requirements of RTCA/DO-362 § 2.4.

(2) The FAA will not grant deviations to exceed the maximum transmit power, exceed the maximum emission bandwidths, exceed the out-of-band emission and susceptibility limits (see Tables 2-1 and 2-2 of paragraphs 2.2.1.8.2.2 and 2.2.1.8.3 of RTCA/DO-362, respectively), deviate from the time-division duplex (TDD) frame structure, increase the antenna gain, change the channelization, or increase the system losses.

4. MARKING.

a. Mark at least one major component of both the GRS and the ARS permanently and legibly with all the information in 14 CFR § 45.15(b). Mark each system radio with the CNPC Link System radio class from Table 1 above. Include in the marking the intended airborne and ground antenna diversity in Table 1 (i.e., S or M).

Example: Mark a Class 1CX ARS (A) with single antenna (S) as "1CXAS".

b. If the system radios include software and/or airborne and ground electronic hardware, then the system radios part numbering scheme must identify the software and airborne/ground electronic hardware configuration. The part numbering scheme can use separate, unique part numbers for software, hardware, and airborne/ground electronic hardware.

c. You may use electronic part marking to identify software or airborne/ground electronic hardware components by embedding the identification within the hardware component itself (using software) rather than marking it on the system nameplate. If electronic marking is used, it must be readily accessible without the use of special tools or equipment.

5. APPLICATION DATA REQUIREMENTS.

You must give the FAA aircraft certification office (ACO) manager responsible for your facility a statement of conformance, as specified in 14 CFR § 21.603(a)(1) and one copy each of the following technical data to support your design and production approval. LODA applicants must submit the same data (excluding paragraph **5.g**) through their civil aviation authority.

a. A Manual(s) containing the following, and including a specification that all references to GRS location, or to distance from the GRS, are to the location of (or distance from) the GRS antenna:

(1) Operating instructions and system limitations sufficient to describe the system radios' operational capability.

(2) The system limitations must include the following statement:

> "The CNPC Link System airborne and ground radios meeting the minimum operational performance standards of this TSO are limited to providing a terrestrial point-to-point communication functionality and radio line-of-sight operation to support UAS operating in the NAS."

(3) Include the following data in the installation manual:

(a) The highest CNPC uplink and downlink data rates, CNPC ARS and GRS minimum transmitter RF output power, minimum receiver sensitivity, minimum antenna gain, and maximum antenna RF connector and cable loss.

(b) For CNPC Link System radio class co-located with C Band avionics systems described in paragraph **3** of this TSO, identify the co-located in-band avionics systems.

(c) For CNPC Link System radio class non-co-located with C Band avionics systems described in paragraph **3** of this TSO, identify the non-co-located in-band avionics systems.

(d) Any unique aspects of the CNPC ARS and GRS antenna(s) such as antenna pattern performance characteristics. Aircraft antenna patterns must include free space patterns and patterns as modified by airframe obstruction at the intended installation location.

(e) If a diplexer is intended to be installed into the CNPC Link System ARS and GRS antenna system, identify installation instructions to ensure insertion of the diplexer does not exceed the maximum cable attenuation allowance between the radio and antenna.

(4) Describe in detail any deviations.

(5) Installation procedures and system radio limitations sufficient to ensure that the CNPC Link System radios, when installed according to the installation or operational procedures, still meet this TSO's requirements.

(a) Limitations must identify any unique aspects of the installation. The limitations must include a note with the following statement:

> "These CNPC Link System radios meet the minimum performance and quality control standards required by a technical standard order (TSO). Installation of these CNPC Link System radios requires separate approval."

(b) For CNPC Link Systems developed to the DAL specified in paragraph **3.b.(6)(b)(2)**, state in the installation limitations the highest UAS risk class with which the CNPC

Link System may be used, based on the highest risk class in paragraph **3.b.(5)**, Table 2, that corresponds to the DAL the system is developed to.

(c) State in the installation limitations that for the C Band Class CNPC Link System installation a directional GRS antenna (as specified in RTCA/DO-362 §3.2.1.1 and Appendix L) must be used, as applicable.

(d) Identify the CNPC Link System manufacturer's Concept of Operations (CONOPS) for the UAS CNPC equipment.

Note: Examples of UAS CNPC Link Systems CONOPS are described in Appendix F, *UAS CNPC Link System Operational Capabilities and Implementation Considerations*, of RTCA/DO-362.

(e) State the UA minimum recommended operating enroute altitude (above ground level (AGL)) for the intended operational environment, considering clutter, manmade structures, and other obstacles.

(f) State the maximum operating range between the CNPC ARS and the CNPC GRS.

(g) State the following limitations for the CNPC Link System operating at the maximum operating range and altitude:

(i) The greatest installed antenna gain reduction (airframe obstruction allowance) from maximum within the UA intended maneuvering envelope; and

(ii) The maximum fade margin due to multipath and diffraction caused by terrain near the radio line of sight path between the two CNPC Link System antennas.

(h) Include information on the FCC license and authorization requirements for the GRS, and include a note indicating that operations must stay within the specified geographic confines authorized to the operator. Include a note indicating that for an ARS operating in conjunction with any GRS, the GRS and the ARS must receive FCC Certification in addition to FAA TSOA approval.

(i) For a C Band Class CNPC Link System radio, state in the limitations that:

(i) No GRS can operate within 10 NM of another GRS;

(ii) One GRS is limited to support one ARS;

(iii) The CNPC ARS must operate in high transmit power mode (see paragraph 2.2.1.6.1.2 of RTCA/DO-362); and

(iv) When the ARS is 9.5 NM or more from its GRS, the CNPC ARS must be operated at or above 3,000 ft AGL.

Note 1: Paragraphs **5.a.(5)(i)(i)** to **5a.(5)(i)(iv)** are intended to ensure that the signal from an ARS will result in an Undesired-to-Desired (U/D)

interference ratio below the maximum tolerable ratio of 44.5 dB at a GRS that is controlling another UA at a maximum distance of 35 nautical miles (NM) from the GRS. (See Appendix R, paragraphs R.2.5.2 and R.3.1 of RTCA/DO-362)

Note 2: Systems that require a distance greater than 35 NM between the ARS and GRS will be evaluated on a case-by-case basis. Additional separation distances and altitude restrictions may be necessary to protect these systems.

(6) For each unique configuration of software and airborne/ground electronic hardware, reference the following:

(a) Software part number including revision and design assurance level;

(b) Airborne/ground electronic hardware part number including revision and design assurance level; and

(c) Functional description.

(7) A summary of the security protection for the UAS CNPC Link System radios.

(8) A summary of the test conditions used for environmental qualifications for each component of the system radios. For example, a form as described in RTCA/DO-160G, *Environmental Conditions and Test Procedures for Airborne Equipment*, Appendix A.

(9) Schematic drawings, wiring diagrams, and any other documentation necessary for installation of the UAS CNPC Link System radios.

(10) List of replaceable components, by part number, that makes up the UAS CNPC Link System radios. Include vendor part number cross-references, when applicable.

b. Instructions covering periodic maintenance, calibration, and repair, to ensure that the UAS CNPC Link System radios continue to meet the TSO approved design. Include recommended inspection intervals and service life, as appropriate.

c. If the system radios include software: a plan for software aspects of certification (PSAC), software configuration index, and software accomplishment summary.

d. If the system radios include simple or complex custom airborne/ground electronic hardware: a plan for hardware aspects of certification (PHAC), hardware verification plan, top-level drawing, and hardware accomplishment summary (or similar document, as applicable).

e. A drawing depicting how the system radios will be marked with the information required by paragraph **4** of this TSO.

f. Identify functionality or performance contained in the system radios not evaluated under paragraph **3** of this TSO (that is, non-TSO functions). Non-TSO functions are accepted in parallel with the TSO authorization. For those non-TSO functions to be accepted, you must declare these functions and include the following information with your TSO application:

(1) Description of the non-TSO function(s), such as performance specifications, failure condition classifications, software, hardware, and environmental qualification levels. Include a statement confirming that the non-TSO function(s) do not interfere with the system radios' compliance with the requirements of paragraph **3**. Show that in the event of a Lost CNPC Link, the non-TSO function(s) not associated with Lost Link condition or procedures are automatically disabled.

(2) Installation procedures and limitations sufficient to ensure that the non-TSO function(s) meets the declared functions and performance specification(s) described in paragraph **5.f.(1)**.

(3) Instructions for continued performance applicable to the non-TSO function(s) described in paragraph **5.f.(1).**

(4) Interface requirements and applicable installation test procedures to ensure compliance with the performance data defined in paragraph **5.f.(1).**

(5) Test plans and analyses, as appropriate, to verify that performance of the hosting TSO system is not affected by the non-TSO function(s).

(6) Test plans and analyses, as appropriate, to verify the function and performance of the non-TSO function(s) as described in paragraph **5.f.(1).**

g. The quality system description required by 14 CFR § 21.608, including functional test specifications. The quality system should ensure that you will detect any changes to the approved design that could adversely affect compliance with the TSO MOPS, and reject the system accordingly. (Not required for LODA applicants.)

h. Material and process specifications list.

i. List of all drawings and processes (including revision level) that define the system radios' design.

j. Manufacturer's TSO qualification report showing results of testing accomplished according to paragraph **3.c** of this TSO.

k. Operational procedures and limitations for the UAS CNPC Link System radios.

6. MANUFACTURER DATA REQUIREMENTS. Besides the data given directly to the responsible ACO, have the following technical data available for review by the responsible ACO:

a. Functional qualification specifications for qualifying each production system to ensure compliance with this TSO.

b. System calibration procedures.

c. Schematic drawings.

d. Wiring diagrams.

e. Material and process specifications.

f. The results of the environmental qualification tests conducted according to paragraph **3.d** of this TSO.

g. If the system radios include software, the appropriate documentation defined in RTCA/DO-178B or RTCA/DO-178C (or RTCA/DO-278A for the CNPC Link System GRS) specified in paragraph **3.e** of this TSO, including all data supporting the applicable objectives in RTCA/DO-178B/C Annex A, *Process Objectives and Outputs by Software Level*.

h. If the system radios include complex custom airborne/ground electronic hardware, the appropriate hardware life cycle data in combination with design assurance level, as defined in RTCA/DO-254, Appendix A, Table A-l. For simple custom airborne/ground electronic hardware, the following data: test cases or procedures, test results, test coverage analysis, tool assessment and qualification data, and configuration management records, including problem reports.

i. If the system radios contain non-TSO function(s), you must also make available items **6.a** through **6.h** as they pertain to the non-TSO function(s) and data showing that in the event of a Lost CNPC Link, the non-TSO function(s) not associated with Lost Link condition or procedures are automatically disabled.

7. FURNISHED DATA REQUIREMENTS.

a. If furnishing one or more system radios manufactured under this TSO to one entity (such as an operator or repair station): Provide one copy or on-line access to the data in paragraphs **5.a** and **5.b** of this TSO. Add any other data needed for the proper installation, certification, use, or for continued compliance with this TSO, of the CNPC Link System radios.

b. If the CNPC Link System radios contain declared non-TSO function(s), include one copy of the data in paragraphs **5.f.(1)** through **5.f.(4).**

8. HOW TO GET REFERENCED DOCUMENTS.

a. Order RTCA documents from RTCA Inc., 1150 18th Street NW, Suite 910, Washington, D.C. 20036. Telephone (202) 833-9339, fax (202) 833-9434. You can also order copies online at www.rtca.org.

b. Order copies of 14 CFR parts 21 and 45 from the Superintendent of Documents, Government Publishing Office, P.O. Box 979050, St. Louis, MO 63197. Telephone (202) 512-1800, fax (202) 512-2104. You can also order copies online at bookstore.gpo.gov.

c. You can find a current list of technical standard orders and advisory circulars on the FAA Internet website Regulatory and Guidance Library at http://rgl.faa.gov/. You will also find the TSO Index of Articles at the same site.

Louis R. Volchansky
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APPENDIX 1
CORRECTIONS TO MINIMUM OPERATIONAL PERFORMANCE STANDARDS

This TSO applies the following corrections to the minimum operational performance standards of RTCA/DO-362 with Errata:

Note: L Band systems are not authorized. Only the Errata to RTCA/DO-362 for C Band system radios are referenced by this TSO.

Added paragraph 2.1.17 C Band ARS Pilot Alerting for Operation Outside Authorized Altitude and Range-to-GRS Envelope.

Paragraphs 2.1.17.1 and 2.1.17.2 describe two acceptable means for the C Band ARS to transmit an alert the pilot when the UA is outside the authorized altitude and range-from-GRS limitations specified in paragraph **5.a(5)(i)(iv)** of this TSO. The ARS **shall** support alerting capability in accordance with either paragraph 2.1.17.1 or 2.1.17.2 below.

Note: All references to GRS location, or to distance from the GRS, are to the location of (or distance from) the GRS antenna.

2.1.17.1 Altitude and Range Indication by CNPC ARS.

The ARS **shall** incorporate an AGL altitude input such as radio altitude or barometric/ geometric altitude minus local terrain elevation;

The ARS **shall** either 1) continuously compute the distance to its GRS, or 2) incorporate a navigation input to continuously receive the distance to its GRS from the navigation system; and

The ARS **shall** transmit a command to alert the pilot whenever the value of the AGL altitude input is below 3,000 ft and the ARS is 9.5 NM or more from its GRS.

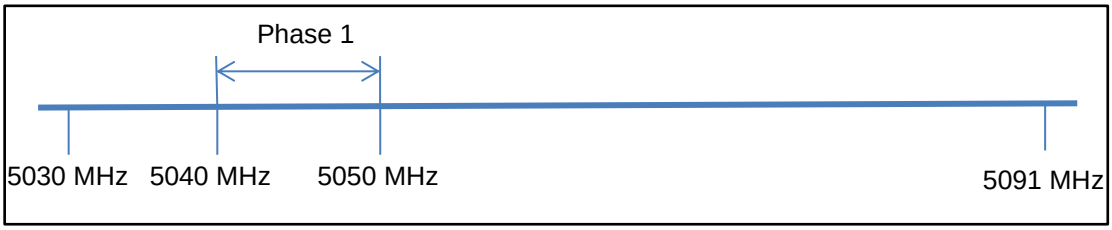
2.1.17.2 Altitude and Range Indication by UA Flight and Radio Management System.

The ARS **shall** support an external command by the UA FRMS to transmit an alert to the pilot whenever the UA is below 3,000 ft AGL and the ARS is 9.5 NM or more from its GRS.

Paragraph 2.2.1.2.2 C Band Tuning Range

Every C Band CNPC Link System **shall** inhibit transmission outside of the frequency range 5040-5050 MHz as shown in Figure 1. The 5040-5050 MHz will be utilized during the first generation implementation (Phase 1) of UAS for CNPC Link.

Figure 1. C Band Tuning Range



Paragraph 2.2.1.2.3 Phase 1 CNPC Link Channelization.

The required downlink-only video transmission sent from the UA to the Pilot Station to support takeoff/landing and emergency operations **shall** be supported on the following channels:

a) Two Takeoff and Landing Channels (Channel A, Channel B), each having a width of 250 kHz.

b) One In-Flight Emergency Channel (Channel C) having a width of 500 kHz.

The non-video channels of Phase 1 consist of various width channels of up to 205 kHz. The assigned channel bandwidth is determined by the needed data for a specific flight (for example, command and control (C2) only, C2 with Air Traffic Control (ATC) voice and data relay, C2 with detect and avoid (DAA), C2 with weather radar data). Therefore, in the Non-video bandwidth you can have any combination of needed channels.

Figure 2. Phase 1 CNPC Link Channelization